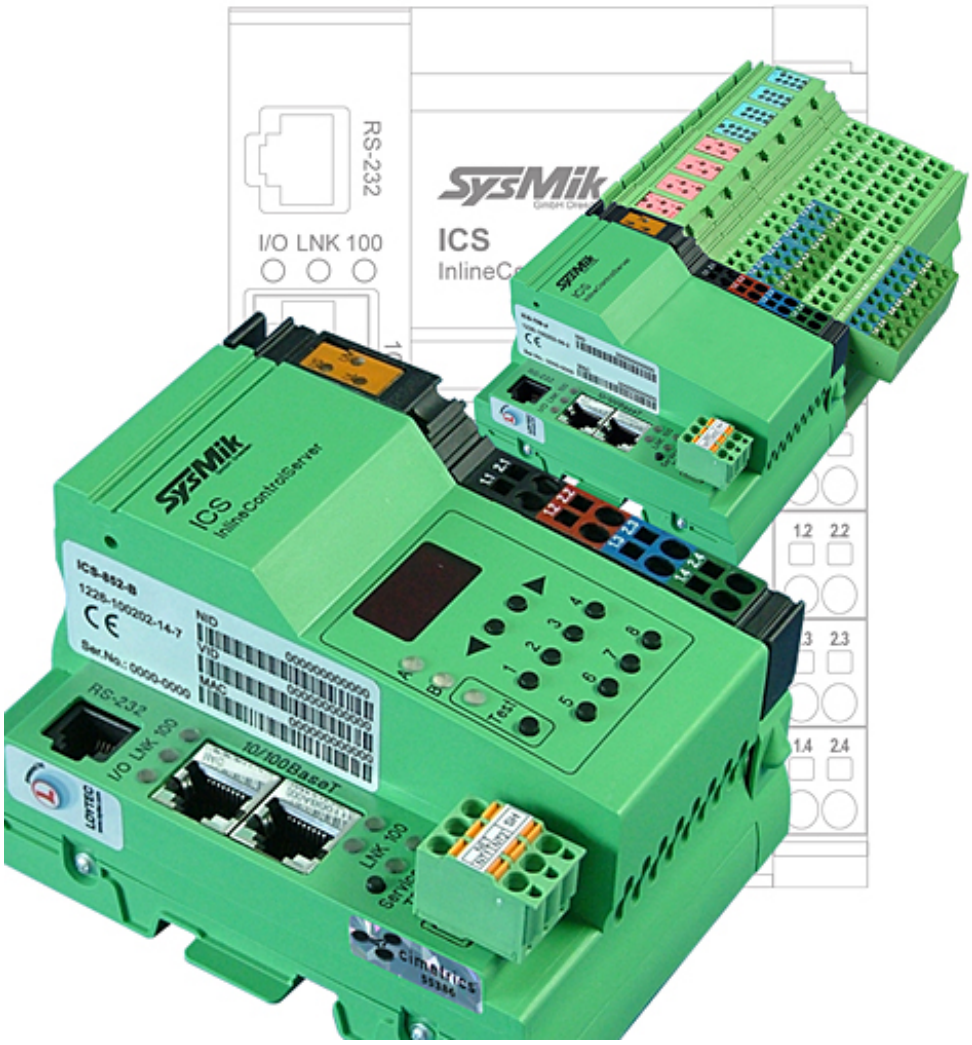
Inline with ICS

Manual



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1 Preamble

This manual supports you in conception, design and commissioning of an Inline station with the InlineControlServer (ICS) as supplement to the ICS manual [1] and the Inline user manual [3].

Specific information about the individual ICS variants and Inline terminals can be found in the appropriate manuals and data specifications.

2 Inline System Design

2.1 Overview

Inline is a modular I/O system by Phoenix Contact allowing for flexible, fast and space saving configuration of automation stations. An Inline station consists of a bus controller and a variety of automation terminals by quantity, type and sequence. In this document they are also shortly referred to as terminals:

- Input and output terminals for digital and analog signals
- Function terminals such as for gateways to other bus systems
- Supply and segment terminals for supply and setup of different voltage levels and fuse protection
- Accessory terminals such as for potential distribution

The bus controller controls the Inline station and includes interfaces to the superordinate system. Up to 63 active automation terminals can be connected to a bus controller. Active terminals are all the I/O and function terminals able to communicate with the bus controller. Power and segment terminals are mainly passive.

An Inline station is assembled without any tools. Potential and data jumpering within a station is achieved without additional wiring. The external terminal points are connected via a pluggable wiring level allowing for pre-wiring and easy terminal exchange.

Inline terminals are designed for DIN rail mounting in closed sub-distributions. The width of automation terminals is indicated in multiples of a modular width (MW), a modular width is equal to 12.2 mm.

2.2 ICS Device Family

The InlineControlServer is a bus controller family including the following core functions:

- Graphical programming
- EIA-709 protocol stack for communication in LONWORKS networks
- Configurable via console

Additional functions are dependant upon the variant chosen:

- EIA-852 protocol stack for LONWORKS over IP (LONMARK channel IP-852)
- Router between TP/FT-10 and IP-852
- RNI (Remote Network Interface) for remote access to a LONWORKS network for project planning, maintenance and visualization
- LPA backend (network interface for the LPA protocol analyzer by Loytec for network traffic diagnosis)
- BACnet/IP interface
- Fidelio interface (interface to the hotel front office solution by MICROS-FIDELIO)

A list of the available ICSs and accessories is included in section 6.1. For further information concerning functions, use and selection of the ICSs please check the ICS manual [1].

2.3 Automation Terminals

This chapter gives an overview of the most important Inline automation terminals for the ICS. There are further terminals supported by the ICS beside the terminals described here. Please contact SysMik ([7]) if you need a specific terminal type that is not listed here.

For more detailed technical information about the terminals please refer to the technical documentations and data sheets from Phoenix Contact. The current version [2] is available for download or can be sent to you upon request. While installing the IPOCS programming tool, the data sheets for the IO Configurator are installed as well. During configuration of a station you can access the data sheets of the terminals used in the IO Configurator. These data sheets are subject to modification by Phoenix Contact.

2.3.1 Digital Inputs

Table 2.3.1.1 represents a selection of available digital input terminals. Further to the number of channels and the module width the input voltage, 24 V DC or 230 V AC, is the most important selection criterion. The column "Connection technology / wires" shows what additional wiring points (GND, +24 V, FE) the terminal offers for each sensor channel. Further information is available in section 3.8.

Device	Channels	Device width in 12.2 mm units	Input voltage / V	Connection technology / wires
IB IL 230 DI 1-PAC	1	1	230	3
IB IL 24 DI 2-PAC	2	1	24	4
IB IL 24 DI 4-PAC	4	1	24	3
IB IL 24 DI 4-ME	4	1	24	3[1)]
IB IL 24 DI 8/HD-PAC	8	1	24	1
IB IL 24 DI 8-PAC	8	4	24	4
IB IL 24 DI 16-PAC	16	4	24	3
IB IL 24 DI 16-ME	16	4	24	3[1)]
IB IL 24 DI 32/HD-PAC	32	4	24	1
Further terminals upon request				

[1)] 3-wires connection only for 2 channels, 1-wire connection for the remaining 2 channels per 12.2 mm unit

Table 2.3.1.1: Comparison of digital input terminals

2.3.2 Digital Outputs

Table 2.3.2.1 represents a selection of supported digital output terminals. Selection criteria are the number of channels, module width, output voltage, maximum load current and connection technology (see also 2.3.1). Digital outputs for 24 V DC and TRIAC outputs for 12 – 253 V DC are available.

Device	Channels	Device width in 12.2 mm units	24 V DC	12-253 V AC	Load current / A	Connection technology / wires
IB IL DO 1 AC-PAC	1	1		✓	0.5	3
IB IL 24 DO 2-PAC	2	1	✓		0.5	4
IB IL 24 DO 2 2A-PAC	2	1	✓		2	4
IB IL 24 DO 4-PAC	4	1	✓		0.5	3
IB IL 24 DO 4-ME	4	1	✓		0.5	3[1)]
IB IL DO 4 AC-1A-PAC	4	4		✓	1	3
IB IL 24 DO 8/HD-PAC	8	1	✓			
IB IL 24 DO 8-PAC	8	4	✓		0.5	4
IB IL 24 DO 8-2A-PAC	8	4	✓		2	4
IB IL 24 DO 16-PAC	16	4	✓		0.5	3
IB IL 24 DO 16-ME	16	4	✓		0.5	3[1)]
IB IL 24 DO 32/HD-PAC	32	4	✓		0.5	1
Further terminals upon request						

[1)] 3-wires connection only for 2 channels, 1-wire connection for the remaining 2 channels per 12.2 mm unit

Table 2.3.2.1: Comparison of digital output terminals

2.3.3 Relay Outputs

Table 2.3.3.1 provides an overview of the available relay terminals.

Features are the number of channels, module width, output voltage, maximum switching voltage and nominal current. The high inrush capability is a special feature for use with capacitive loads as is found in luminaires.

Device	Channels	Device width in 12.2 mm units	Max. switching voltage / V AC	Rated current/ A	Gold plated contacts	High inrush current
IB IL 24/230 DOR 1/W-PAC	1	1	230	3	✓	
IB IL 24/230 DOR 1/W-PC-PAC	1	1	230	3		
IB IL 24/48 DOR 2/W-PAC	2	1	48	2	✓	
IB IL 24/230 DOR 4/W-PAC	4	4	230	3	✓	
IB IL 24/230 DOR 4/W-PC-PAC	4	4	230	3		
IB IL 24/230 DOR 4/HC-PAC	4	4	230	16[1)]		✓
Further terminals upon request						

[1)] Several outputs up to 16 A while observing derating conditions!

Table 2.3.3.1: Comparison of relay terminals

2.3.4 Analog Inputs

Table 2.3.4.1 shows an overview of available analog input terminals. The terminals vary according to the number of channels, module width, dimensions and connection technology of the sensors.

Measurement categories are current in the range 0 – 20 mA, voltage in the range of 0 – 10 V and resistance or temperature for Pt1000. In addition, some terminal types can be used for different measuring ranges.

Note: Detailed information referring to connection procedure and measuring range is available in the terminal related data sheets.

Device	Channels	Device width in 12.2 mm units	Voltage	Current	Resistance / temperature	Connection technology / wires
IB IL TEMP 2/RTD-PAC	2	1			✓	4
IB IL AI/TEMP 4 RTD-PAC	4	1	✓		✓	2
IB IL TEMP 4/8 RTD-PAC	8	4			✓	3
IB IL AI 2/SF-PAC	2	1	✓	✓		2-3
IB IL AI 2/SF-ME	2	1	✓	✓		2
IB IL AI 4/EF-PAC	4	4	✓	✓		2-4
IB IL AI 8/SF-PAC	8	4	✓	✓		2
Further terminals upon request						

Table 2.3.4.1: Comparison of analog input terminals

2.3.5 Analog Outputs

Table 2.3.5.1 shows an overview of available analog output terminals. The terminals differ in the number of channels, module width, output dimensions, load resistance, and resolution. The usual output ranges are voltage in the range 0-10 V and current in the 0 - 20 mA range. In addition, some terminal types can be used for different output ranges.

Note: Detailed information referring to connection technology and output range is available in the terminal related data sheets.

Device	Channels	Device width in 12.2 mm units	Voltage	Current	Load resistor / kΩ	Resolution / Bit	Connection technology /wires
IB IL AO 1/SF-PAC	1	2	✓	✓	>2	16	2
IB IL AO 1/U/SF-PAC	1	1	✓		>2	16	2
IB IL AO 2/SF-PAC	2	4	✓	✓	>2	16	2
IB IL AO 2/U/BP-PAC	2	1	✓		>2	12	2
IB IL AO 2/U/BP-ME	2	1	✓		>2	12	2
IB IL AO 4/U/SF-PAC	4	1	✓		>1	10	2
IB IL AO 4/8/U/BP-PAC	8	4	✓		>2	15	2
Further terminals upon request							

Table 2.3.5.1: Comparison of analog output terminals

2.3.6 Function Terminals

Function terminals supported by the ICS are DALI terminals for lighting control and the S0 terminals shown in table 2.3.6.1. For selection please observe the terminal related data sheet.

Device	Function
IB IL DALI/PWR-PAC	DALI master with DALI supply
IB IL DALI-PAC	DALI master, extension for IB IL DALI/PWR-PAC
IB IL DI 8/S0-PAC	S0 pulse counter, digital inputs

Table 2.3.6.1: Function Terminals

2.3.7 Power and Segment Terminals

The supply of power to an Inline-Station is initially achieved via the bus controller. If the requirements of the I/O terminals in an application exceed the capacities of the bus controller, e.g. concerning power requirement or galvanic isolation, additional supply and segment terminals will be required.

Supply and segment terminals are required for:

- Assembly of galvanically isolated areas (e.g. 24 V and 230 V)
- Assembly of separated segments in the 24 V DC range (such as for separated fuse protection)
- Additional supply of electric circuits if the current capacity of the potential jumpering has been reached or the maximum power load of the source is exceeded.

Table 2.3.7.1 is a selection support for power and segment terminals.

Device	Type	Supply	Main circuit fuse	Segment circuit fuse	Diagnosis
IB IL 24 PWR IN-PAC	Power terminal	U_M [1] / U_S [2]			
IB IL 24 PWR IN/F-PAC			✓		
IB IL 24 PWR IN/2-F-PAC			✓	✓	
IB IL 24 PWR IN/2-F-D-PAC			✓	✓	✓
IB IL 24 PWR IN/2F-DF-PAC			✓	✓	✓
IB IL 24 PWR IN/R-PAC		U_L [3], U_{ANA} [4], U_M [1], U_S [2]			
IB IL 230 PWR IN-PAC		L [5]			
IB IL 24 SEG-PAC	Segment terminal	U_S [2]			
IB IL 24 SEG/F-PAC				✓	
IB IL 24 SEG/F-D-PAC				✓	✓
IB IL 24 SEG-ELF-PAC				✓	✓

[1] U_M Main voltage, see 3.5.1
[2] U_S Segment voltage, see 3.5.1
[3] U_L Logic voltage, see 3.5.1
[4] U_{ANA} Analog voltage, see 3.5.1
[5] L Line in voltage area 120 V AC / 230 V AC

Table 2.3.7.1: Comparison of power and segment terminals

2.3.8 Accessory Terminals

Part of the accessory terminals are

- Potential distribution terminals to provide additional terminal points for supply and ground
- Distance terminals for galvanic isolation of different voltage ranges from each other (e.g. 24 V DC and 230 V AC)

Table 2.3.8.1 shows an overview of the available accessory terminals.

Device	Type
IB IL PD 24V-PAC	Terminal for 24 V potential distribution
IB IL PD GND-PAC	Terminal for GND potential distribution
IB IL DOR LV-SET-PAC	Spacer terminal block to separate voltage areas

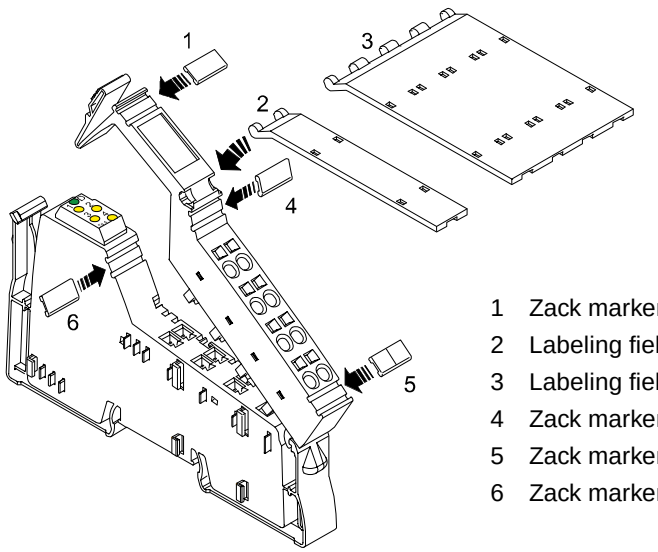
Table 2.3.8.1: Overview of the accessory terminals

2.4 Accessories

2.4.1 Additional Labeling

There are various options for labeling the slots and terminal points (see figure 2.4.1.1):

1. Each connector can be labeled individually using Zack markers.
2. A labeling field covering one connector can be individually labeled with text.
3. A large labeling field similar to 2 but covering four connectors.
4. A Zack marker identifies the upper signals (signals 1 and 2 on a double signal connector).
5. A Zack marker identifies the lower signals (signals 3 and 4 on a double signal connector).
6. Each slot of the electronics base can be labeled using a Zack marker.



1 Zack marker for the connector
2 Labeling field covering one connector
3 Labeling field covering four connectors
4 Zack marker for upper terminal points
5 Zack marker for lower terminal points
6 Zack marker for electronics socket

5520C036

Figure 2.4.1.1: Labeling options

2.4.2 End Clamps

End clamps are required for secure fixating of the Inline station to keep it from moving side to side on the mounting rail.

Note: For Inline with ICS only such end clamps should be used which do not project the mounting rail by more than 30 mm to avoid blocking the release of connected Ethernet plugs.

2.5 Color Identification of the Terminal Types

2.5.1 Base and Connector Colors for the different Voltage Areas

The basic range of a terminal voltage can be recognized by the color of housing and plug (see table 2.5.1.1).

Area	Housing color	Connector color
SELV (Safety Extra Low Voltage) terminals (24 V DC)	green	green or black
Mains voltage (120 V AC / 230 V AC)	gray	Gray
Isolation between SELV and mains areas	gray	green / gray divided green points to the SELV area gray points to the mains area

Table 2.5.1.1: Housing and connector color

2.5.2 Color of Terminal Points Identifying Function

There are connectors with or without terminal points identified in terms of color. Table 2.5.2.1 shows the meaning of the color identifications.

Color	Description
24 V DC area	
Red	+
Blue	-
Green	Functional Earth FE
120 V AC / 230 V AC area	
Black	Line L
Blue	Neutral N
Green/Yellow	Protective Earth PE

Table 2.5.2.1: Terminal point color identification

2.5.3 LED Background Color Identifying Function

For visual recognition of their function the terminals are identified in terms of color on their top side in the area of the LED displays (see figure 2.5.3.1 and table 2.5.3.1).

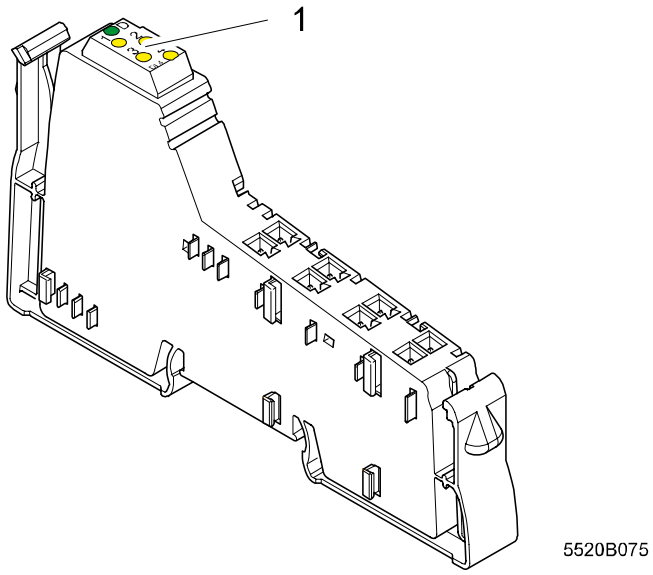


Figure 2.5.3.1: Color identification of the terminal function

Color	Description
24 V DC area	
Black	Supply terminal / segment terminal
Light blue or blue	Digital input
Pink or red	Digital output
Green	Analog input
Yellow	Analog output
Orange	Function terminal
120 V AC / 230 V AC area	
White with flash symbol	Supply terminal
Dark blue with flash symbol	Digital input
Claret-red with flash symbol	Digital output

Table 2.5.3.1: Color identification of the function

2.6 Diagnosis and Status Displays

For failure diagnosis on site all terminals are provided with diagnosis and partially with status LEDs. The diagnosis LEDs indicate the operational status of the terminal. A terminal operates properly if all diagnosis LEDs are illuminated green.

Status LEDs indicate the status of the appropriate input/output.

Table 2.6.1 shows an overview of displays on different terminal types with uniform signification. The diagnosis and status displays provided by a terminal can be found in the terminal specific data sheet.

LED	State	Description
UL	On	U_{BK} (24 V supply) and U_L (7.5 V logic voltage) OK
	Off	U_{BK}, U_L not OK
UM	On	Voltage at main circuit (+24 V DC)
	Off	No voltage at main circuit
US	On	Voltage at segment circuit (+24 V DC)
	Off	No voltage at segment circuit
D (Diagnosis)	Off	No logic voltage
	On	Logic voltage ok, data transmission on local bus is active
	0.5 Hz	Logic voltage ok, no data transmission on local bus
	2 Hz	Logic voltage ok, I/O error is present (see specific terminal documentation)
	4 Hz	Logic voltage ok, error at connection between previous and flashing terminal, e.g. loose contact, terminal before the flashing terminal failed, terminal hot-plugged (not permitted)

Table 2.6.1: Diagnosis LEDs in Inline with general signification

3 Assembly, Installation and Commissioning

3.1 Safety Advices

3.1.1 Intended Use

Inline terminals are exclusively intended for use within an Inline station according to the information in the terminal specific data sheets and this document.

Note: Disconnect the entire station from the power supply prior to removing a terminal from the station or inserting a terminal in the station! Only reconnect after the entire stations has been set-up.

3.1.2 Use in Low Voltage Range

Warning! Only qualified personnel (electricians or electro-technical skilled persons) are entitled to perform on Inline terminals within the range outside the safety extra-low voltage (SELV). **During installation and commissioning please implicitly observe the notes in the terminal specific data sheets.**

Warning! Removing and inserting terminals for voltage ranges 120 V AC and 230 V AC is only to be carried out in the disconnected status! For all actions involving terminals and wiring always disconnect the supply voltage and secure against accidental reconnection..

Warning! The Inline terminals for the 120 V AC and 230 V AC voltage areas should only be operated in grounded AC voltage networks (AC networks).

Note: Protect any low voltage range by an individual external fuse. Choose the value of the fuse in accordance with the line capacity, the maximum value of the fuse may not exceed 8 A. Please check the supply terminal data sheets for further restrictions!

3.2 Mounting and Removing Inline Terminals

3.2.1 Mounting Requirements

Terminals of the Inline family with protection class IP 20 are designed for use in an enclosed switch cabinet or switch cabinets for snap assembly on DIN rails 35 mm x 7.5 mm according EN 60715 (supersedes EN 50022).

Note: For optimum stability fix the DIN rail on a mounting plane or a back plane.

The locking plate secures the end of an Inline station, protecting the station from electro static discharge pulses. The locking plate is part of the ICS scope of supply.

Appropriate appliances such as end clamps have to be provided on both sides of the device in order to prevent the station from lateral movement on the mounting rail.

Note: At the connection side of the ICS only, end brackets or terminals should be used which don't project beyond the mounting rail by more than 30 mm to avoid blocking the release of connected Ethernet plugs. The end bracket CLIPFIX 35 fulfills this requirement (while CLIPFIX 35-5 does not).

3.2.2 Mounting Terminals

An Inline station is assembled by plugging the individual components into each other. Lining-up establishes the potential and bus signal connection between the individual components of the station. To latch a terminal, proceed as per figure 3.2.2.1:

1. Disconnect the station from the power supply and insure no possible accidental reconnection is possible. Snap the electronic base on the mounting rail (A). Adjacent terminals are connected by keyway/featherkey connections (B).

   First insert the local bus contacts in the keyways of the previous terminal (B1).

   Insert the other potential jumpers into their keyways until they are securely locked (B2).

   Please make sure the contacts are properly connected (C2). C1 shows a common error where the featherkey is not in the keyway.
2. Once all the bases have been snapped on, plug the connectors into the appropriate bases. First place the front connector shaft in the front snap-on mechanism (D1), then pivot the top of the connector towards the base until it snaps into the back snap-on mechanism.

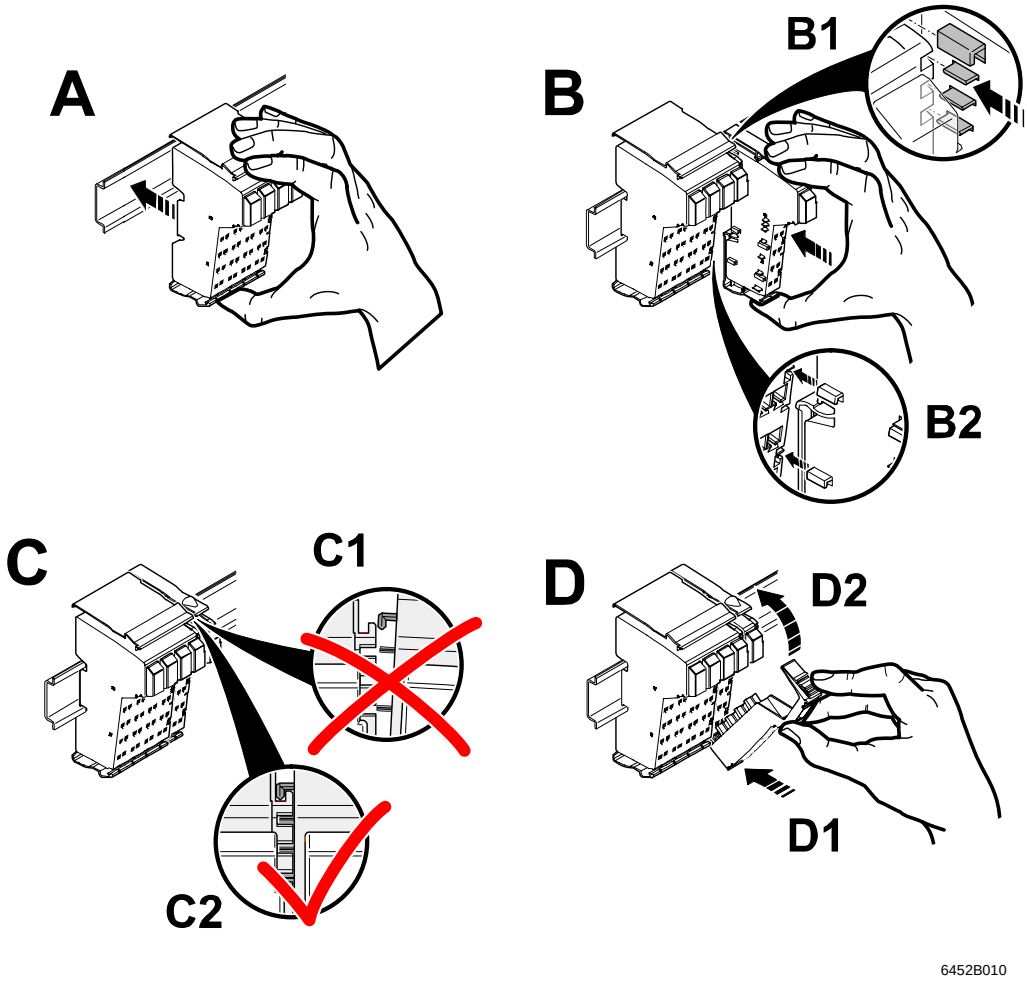


Figure 3.2.2.1: Installation on the mounting rail (A), connection of Inline components to each other (B), connection check (C), plugging the wiring level (D)

3.2.3 Removing and Exchanging Terminals

Individual terminals can be exchanged after set-up of the station. Figure 3.2.3.1 shows the removal of a terminal. Please observe the following procedure:

3. Disconnect the station from the power supply and secure it against reconnection.
1. If there is a labeling field, which covers several connectors, it may be necessary to remove it (A1).
2. Lift the connector of the terminal to be removed by pressing on the back connector shaft latching (A2) and remove the connector (B).
3. Remove the adjacent connectors of the neighboring terminals (C).
4. Press the snap-on mechanism (D1) and remove the electronics base from the mounting rail by pulling the base straight back (D2).

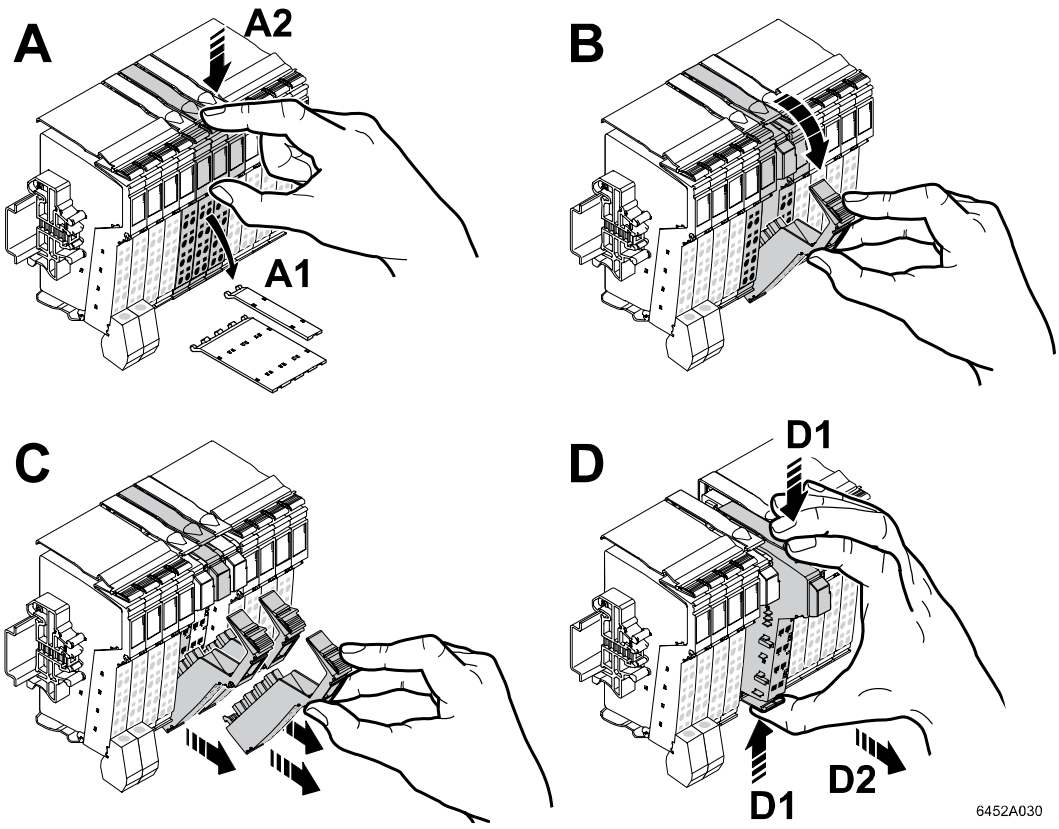


Figure 3.2.3.1: Removing a terminal

If you want to exchange a terminal, remove the appropriate terminal and insert the base of the new terminal at its position. Please ensure that all featherkeys and keyways on adjacent terminals are interlocked.

3.3 Grounding

3.3.1 Functional Earth Ground (FE)

Functional earth grounding improves immunity to interference and is used for Inline within the 24 V DC area (SELV).

Functional earth ground is led from the grounded bus coupler or power terminal through the 24 V DC area of the station using the FE potential jumper.

For a reliable functional earth grounding please make sure that:

- The mounting rail is connected to the functional earth via grounding terminals with a wire of minimum diameter of 1.5 mm² (16 AWG).
- The FE spring (metal clip) at the bottom side of bus controllers, power and segment terminals have electrical contact with the mounting rail. The mounting rail has to be clean and corrosion-free.
- The bus controller is additionally grounded via the earth leakage protection clamping spot with a 1.5 mm² conductor and grounding terminal (see figure 3.3.1.1).
- 120 V AC or 230 V AC voltage areas interrupt the FE potential jumper. Therefore, a 24 V DC power terminal which is located directly behind such an area, must also be grounded using the FE terminal point (see terminal specific data sheet).

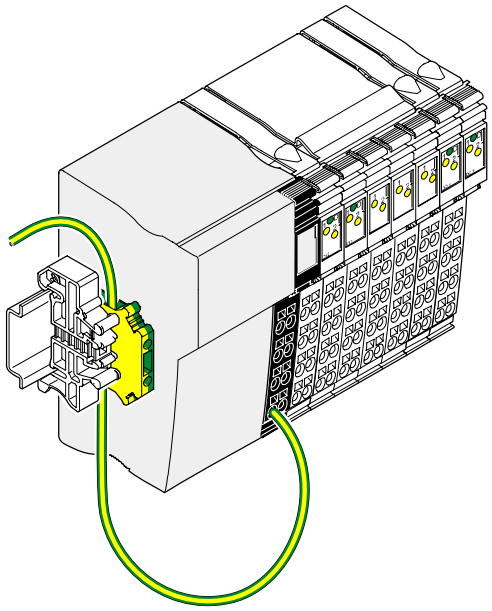


Figure 3.3.1.1: Diagram of the additional functional earth grounding of a bus controller

3.3.2 Protective Earth

Protective earth is a low-impedance path to protect the user from electric shock in case of a failure and is used outside the SELV area in the Inline system.

Warning! Each power terminal of the 120 V AC or 230 V AC area must be connected to the mounting rail with low impedance (min. 1.5 mm^2 / AWG 16), otherwise no protection is provided (see figure 3.3.2.1). Furthermore, the mounting rail itself must be properly grounded as well.

The PE (protective earth ground) potential jumper is led from the power terminal of the 120 V AC or 230 V AC area through this entire area to the next power terminal.

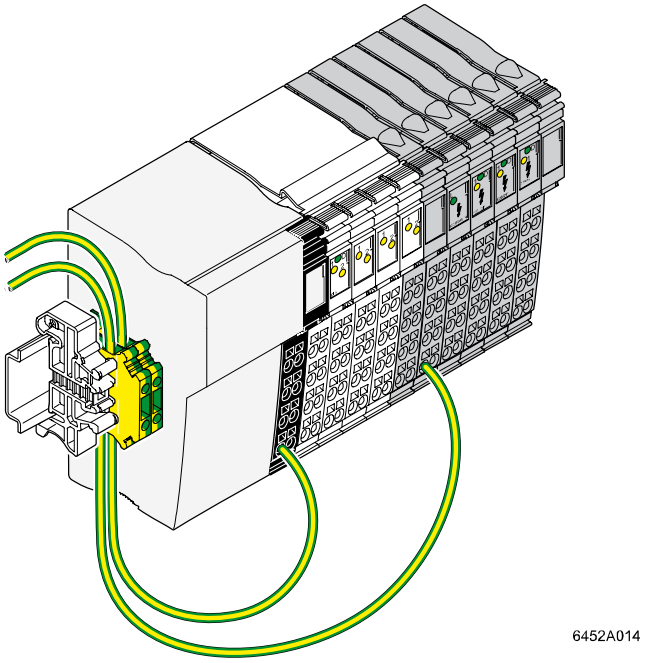


Figure 3.3.2.1: Diagram of the additional grounding of a bus controller and protective earth ground connection

3.4 Shielding

3.4.1 Shielding Directions

Fasten the shielding so that as much of the braided shield as possible is held underneath the clamp of the shield connection..

Make sure there is good contact between the connector and base.

For shielding of the TP/FT-10 cable please observe the recommendations in [6].

3.4.2 Shielding of Analog Sensors and Actuators

Always connect analog sensors and actuators using shielded, twisted-pair cables.

For connection please observe the respective instructions in the terminal specific data sheets.

3.5 Supply, Potential- and Data Jumpering

3.5.1 General

There are several electric circuits within an Inline station, automatically set-up by latching the terminals to each other. The voltage of the different electric circuits is supplied to the connected terminals via potential jumpers. The bus terminal supply U_{BK} is connected to the ICS. The ICS, supplied by U_{BK}, is generating the voltages for the logic circuit U_L and the analog circuit U_{ANA}.

The main circuit with the voltage U_M begins either at the bus controller or a power terminal and is led through the subsequent terminals to the next power terminal.

From U_M the segment voltage U_S can be tapped via different segment terminals. Thus several segments independent from each other can be set-up in the main circuit. The main circuit provides the supply voltage for these segments.

Table 3.5.1.1 shows an overview of the type and significance of these electric circuits and voltages in an Inline station.

Circuit	Description	Limits
Bus coupler supply U_{BK}	24 V DC; this circuit supplies the ICS which generates the bus logic voltage and the analog voltage for the I/O terminals	19.2 V DC to 30 V DC
Logic circuit U_L	7.5 V DC; this circuit supplies the protocol chips of the terminals	7.13 V DC to 7.87 V DC max. 2 A
Analog circuit U_{ANA}	24 V DC; auxiliary voltage for analog peripherals of the terminals	20.4 V DC to 28.8 V DC max. 0.5 A
Segment circuit U_S	24 V DC; supply of the peripherals of most terminals (e.g. digital inputs)	19.2 V DC to 30 V DC, max. 8 A
Main circuit U_M	24 V DC; at segment terminals, the segment voltage U_S is provided from the main circuit U_M	19.2 V DC to 30 V DC, max. 8 A

Table 3.5.1.1: Inline electric circuits and voltages

The following sections provide an overview of the different supply options of an Inline station, from the easiest supply option via the bus controller, the supply of galvanically isolated ranges through to the additional supply of analog, logic, main and segment voltage.

There are three selection criteria:

- Requirements of the application concerning voltage (24 V or 230 V AC) and fuse protection.
- Current consumption of the connected sensors and actuators
- Current consumption of the connected automation terminals from the logic circuit and the analog circuit.

Note: The IPOCS IO Configurator indicates the approx. current consumptions, so you can decide to insert additional power terminals. Please observe the information in the terminal specific data sheets.

3.5.2 24 V DC Supply at the ICS from One Source

The easiest option is to supply the station from the ICS using a single 24 V DC source. (see figure 3.5.2.1). Conditions are:

- The total current consumption of all Inline automation terminals from the logic circuit is max. 2 A.
- The total current consumption of all Inline automation terminals from the analog circuit is max. 0.5 A.
- The current from potential jumpers (U_M, U_S, GND) nowhere exceeds 8 A.
- Derating (current load depending on the ambient temperature) is observed for devices with Ethernet connection.

Note: When calculating the power supply and fuse requirement please observe that the power supply unit has to provide the quadruple nominal current for safe activation of the fuse. The maximum value of the fuse may be 8 A.

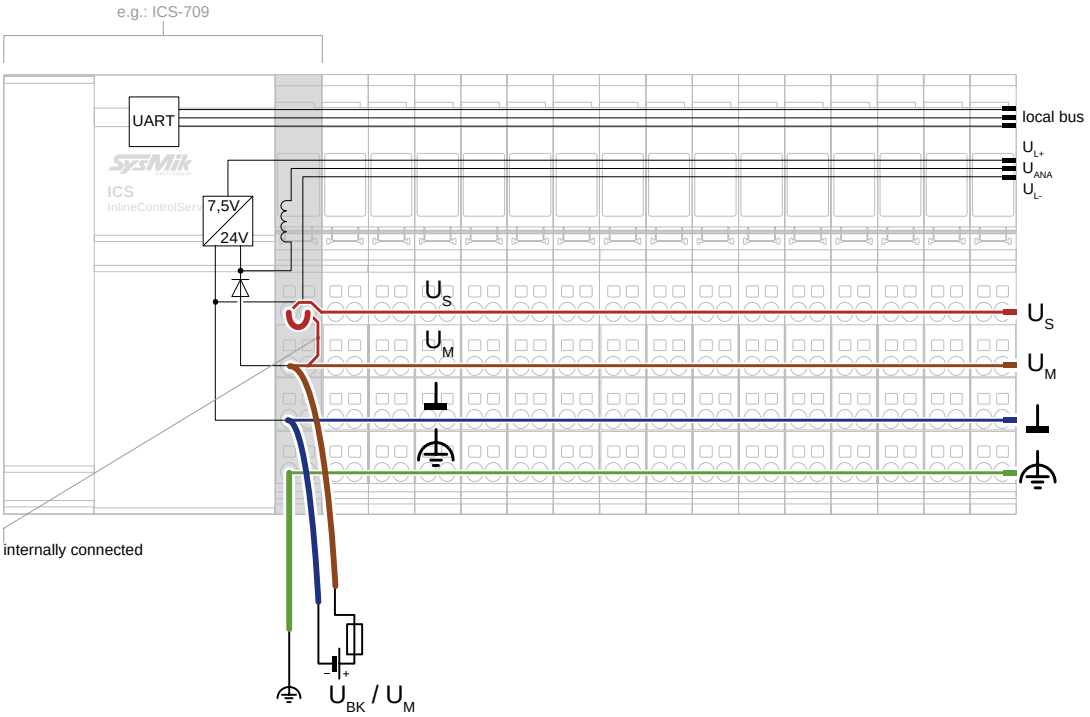


Figure 3.5.2.1: 24 V DC supply at the bus controller

3.5.3 Additional Supply of Main and Segment Voltage with IB IL 24 PWR IN

Additional supply of main and segment voltage (see figure 3.5.3.1) is required if either the allowed current of the potential jumpers U_M, U_S or GND is exceeded or groups of actuators or sensors are to be supplied galvanically isolated from each other. Figure 3.5.3.1 shows that the circuits U_{M1} and $U_{S1.1}$ and functional earth end at the power terminal IB IL PWR IN-PAC and are galvanically isolated from the circuits U_{M2} and $U_{S2.1}$.

Please observe the note from section 0 concerning dimensioning of power supply and fuse.

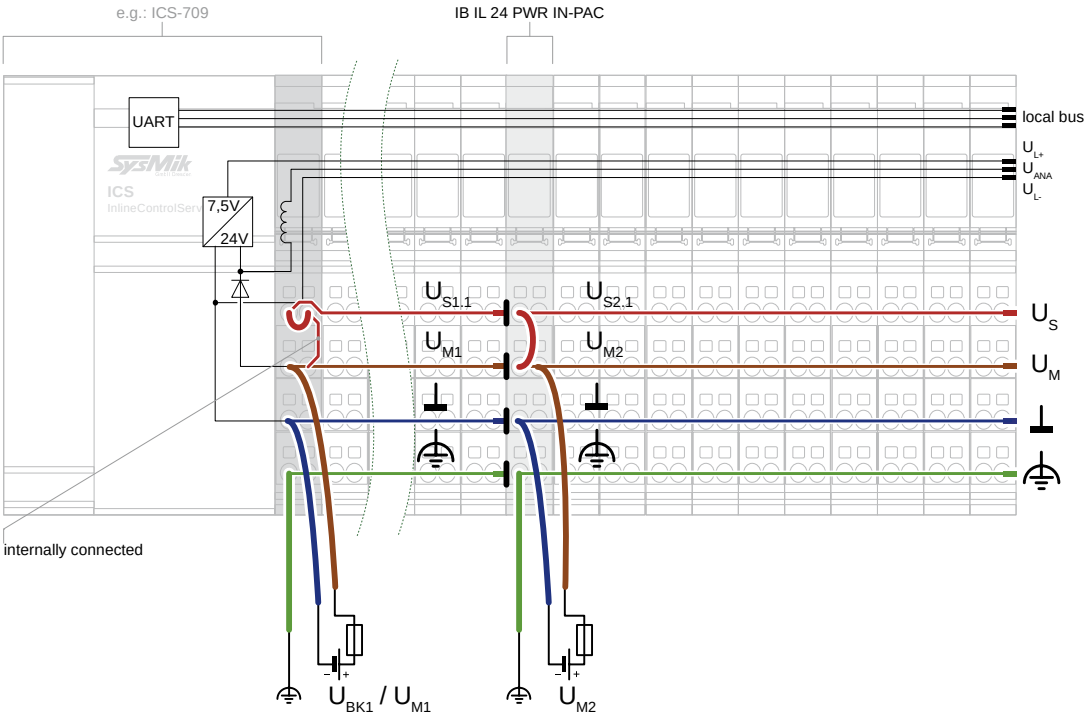


Figure 3.5.3.1: Additional supply at IB IL 24 PWR

3.5.4 Segmentation of U_M and U_S for Actuator and Sensor Supply

Figure 3.5.4.1 shows the Inline system options for segmentation of U_M and U_S for actuator and sensor supply. As described in 3.5.3, separate main circuit areas can be created by means of the IB IL PWR IN-PAC terminals. A main voltage range can be further segmented by means of the IB IL 24 SEG-PAC terminals in order to fuse or switch segments individually.

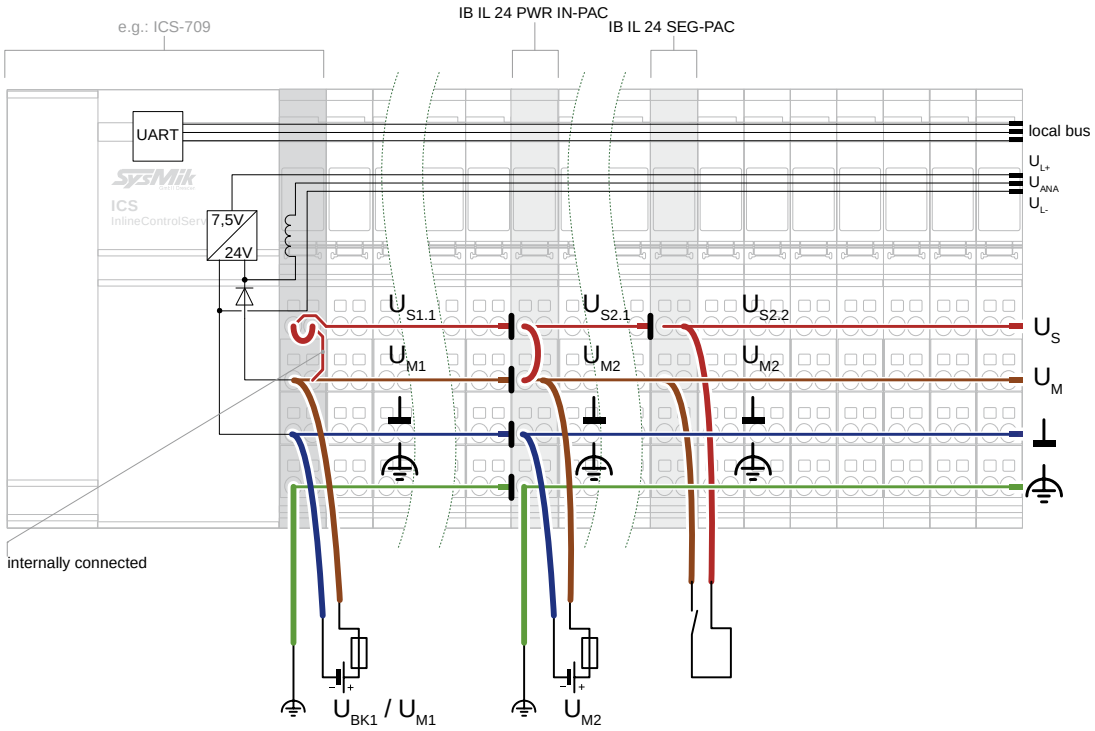


Figure 3.5.4.1: Potential jumpering for segmentation within an Inline station

3.5.5 Design of an AC area (e.g. 230 V)

Figure 3.5.5.1 shows the design of an Inline station with an AC area such as for TRIAC terminals. AC areas have to be set-up galvanically isolated from the rest of an Inline station, this especially applies to supply voltage. The supply terminal IB IL 230 PWR IN-PAC is used for galvanic isolation and AC supply. If possible, the AC area should be placed at the end of the Inline station to avoid setting-up a subsequent 24 V area with individual supply.

Warning! Please observe the safety note in 3.1.2.

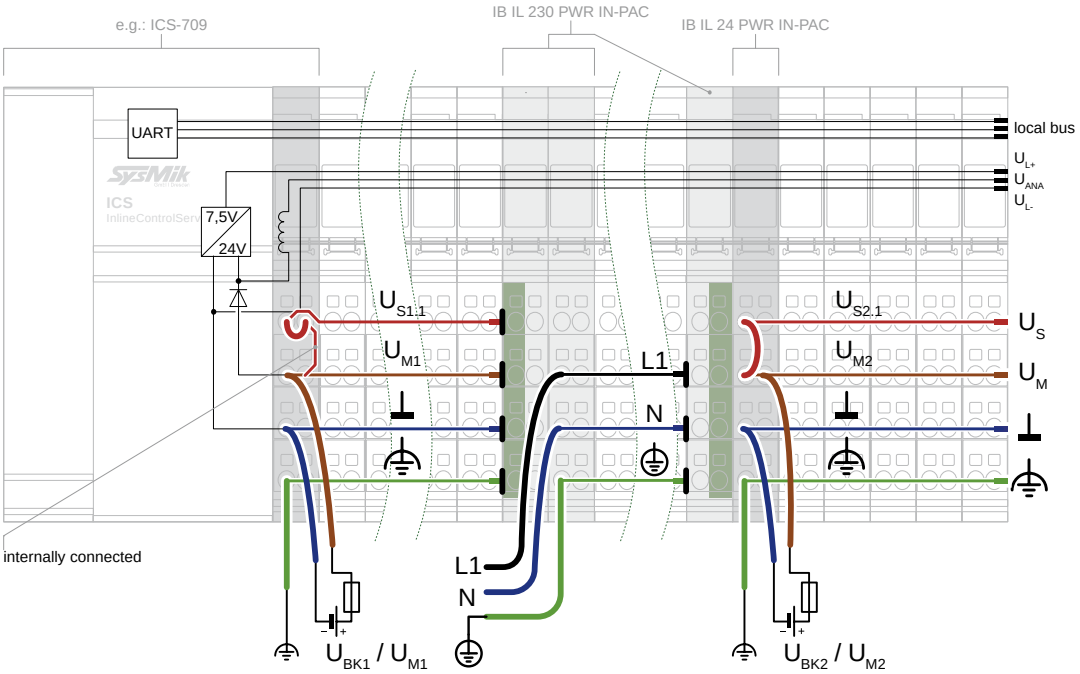


Figure 3.5.5.1: Potential jumpering within an Inline station when setting-up an AC range

3.5.6 Switching of 230 V AC with Relays

No supply is required when switching 230 V AC with relays, but galvanic isolation from the remaining Inline station. The isolation is achieved by the distance terminal IB IL DOR LV-SET-PAC (see figure 3.5.6.1).

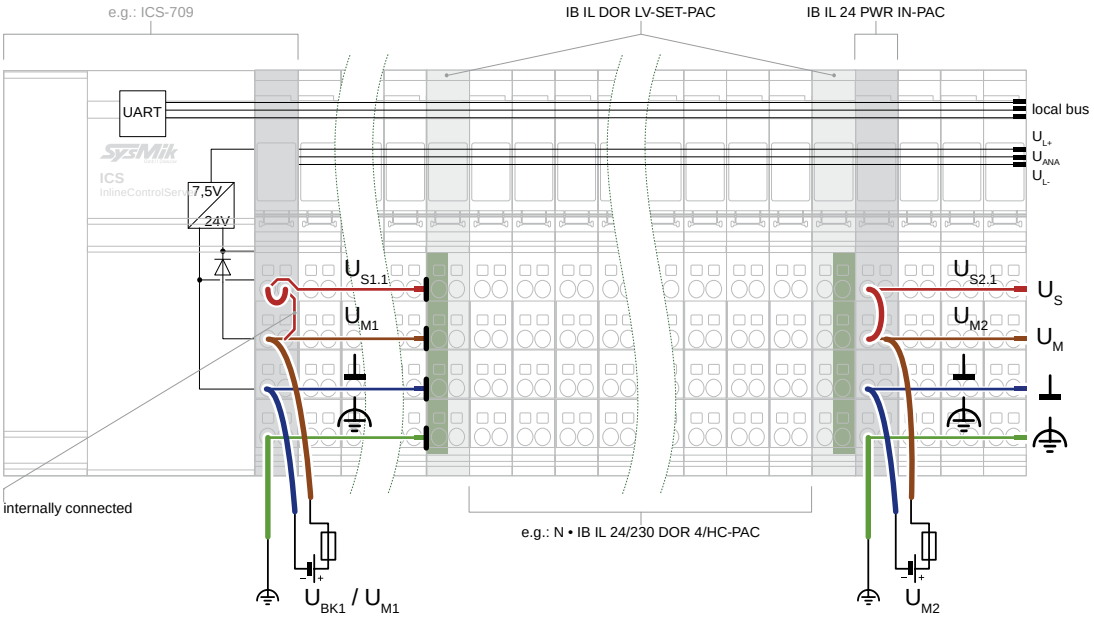


Figure 3.5.6.1: Switching 230 V AC within an Inline station

Warning! Please observe the safety note in section 3.1.2.

Additional Supply of Logic and Analog Voltage

Exceeding the maximum cumulative current for logic or analog circuit by the connected automation terminals is not permitted and can be avoided by additional supply using the terminal IB IL 24 PWR IN/R-PAC (see figure 3.5.7.1).

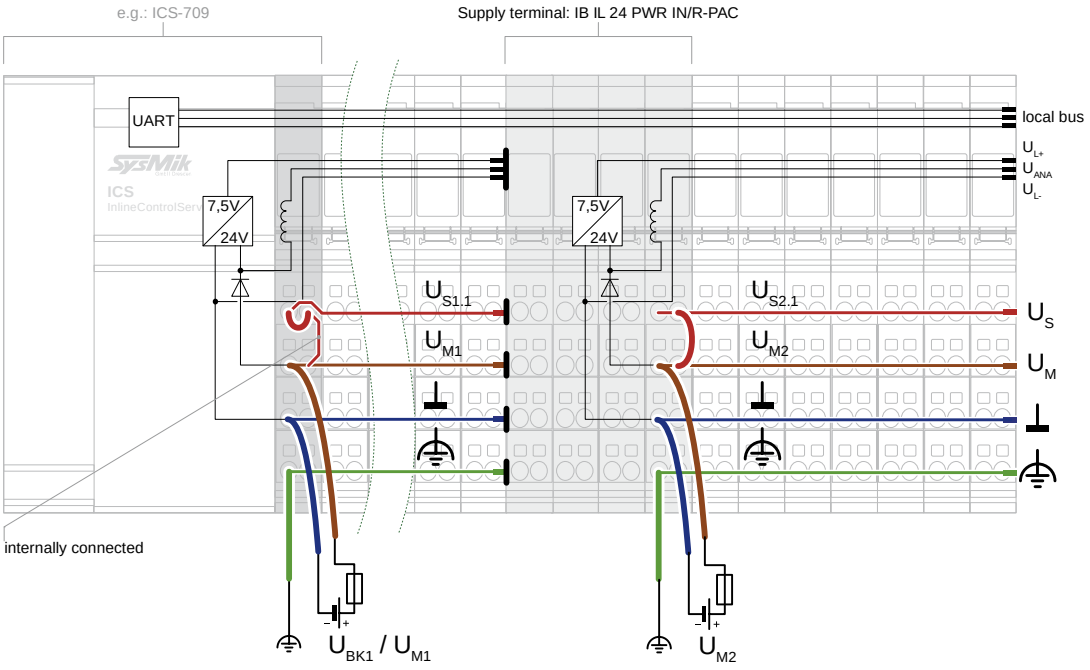


Figure 3.5.7.1: Additional supply of analog, logic, main and segment voltage

3.6 Sequence of the I/O Terminals

Always arrange the terminals in the order of their current drain within a main circuit.

A main circuit always begins at a bus controller or a supply terminal and goes to the next supply terminal. If no supply terminal is used the entire station is a single main circuit.

Note: Install the terminals with the highest current drain first. The advantage is that the high supply current does not flow through the entire main circuit and thus not through all terminals.

This results in the following advised sequence:

1. Digital output terminals
2. Digital input terminals including S0 counter terminal
3. Analog terminals
4. Relay and DALI terminals at the end of the station as they interrupt U_M

This rule concludes that terminals should be grouped according to their type.

3.7 Placement of Analog Terminals

As current through the potential jumpers U_M and U_S generates heating which decreases the measuring accuracy, all analog terminals of a main circuit should always be placed conjointly at the end of a main circuit (see 3.6).

If analog terminals cannot be placed at the end of a station (e.g. due to cable length), a new main circuit for the subsequent terminals should be set-up by inserting a power terminal.

3.8 Connecting Sensors and Actuators

3.8.1 Connection Technology

The digital I/O terminals of the Inline product family generally allow for connection of sensors and actuators in 1, 2, 3 or 4 wire technology. Analog terminals allow for connection of sensors in 2, 3- or 4 wire technology.

Due to connector variants the following wiring technologies can be achieved at a single connector:

- 8 sensors or actuators in 1 wire technology
- 2 sensors or actuators in 2, 3 or 4 wire technology
- 4 sensors or actuators in 2 or 3 wire technology
- 2 sensors or actuators in 2, 3 or 4 wire technology with shielding (for analog sensors or actuators)

3.8.2 Connecting Digital In- and Output Terminals

The following section deals with the connection options using terminals of the 24 V DC area as an example. The specifications apply appropriately adapted for the 120 V AC and 230 V AC range. A connection example is provided in each terminal specific data sheet.

Connection	1-Wire	2-Wires	3-Wires	4-Wires
Sensor signal	✓	✓	✓	✓
Sensor supply	external	X[1)]	✓	✓
Ground	-	-	✓	✓
Earth / shield	-	-	-	✓

[1)] NPN type input terminals use sensor signal and ground as 2-wire connection.

Table 3.8.2.1: Overview of digital input terminal connections

Connection	1-Wire	2-Wire	3-Wire	4-Wire
Actuator signal	✓	✓	✓	✓
Actuator supply	-	-	✓	✓
Ground	external	✓	✓	✓
Earth / shield	-	-	-	✓

Table 3.8.2.2: Overview of digital output terminal connections

3.8.3 1-Wire Connection of Digital Terminals

Figure 3.8.3.1 shows the 1-conductor connection of digital actuators and sensors.

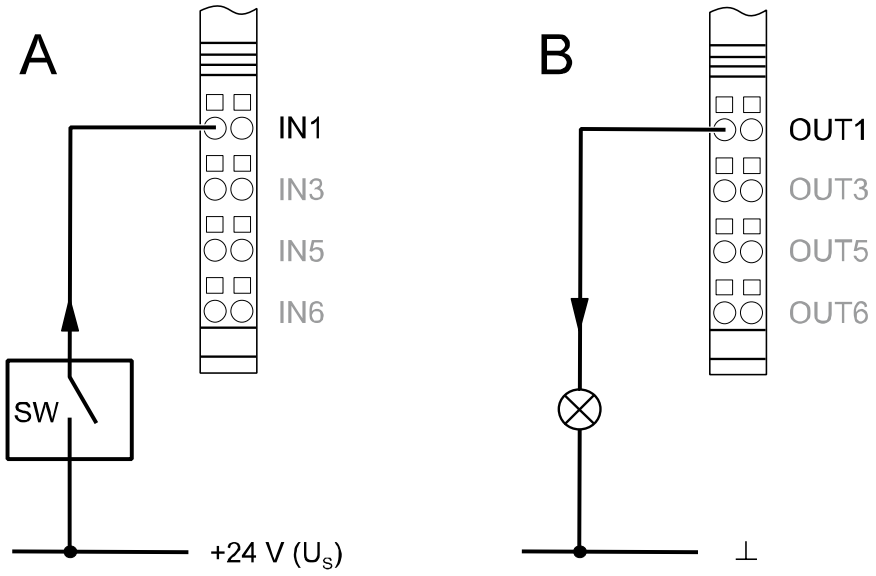


Figure 3.8.3.1: 1-wire connection of digital sensors (A) and actuators (B)

Note: Sensors and the segment circuit of the Inline station have to be provided by the same voltage supply. Grounding of the actuators and grounding of the segment voltage supplying the actuators must have the same potential.

3.8.4 2-Wire Connection of Digital Terminals

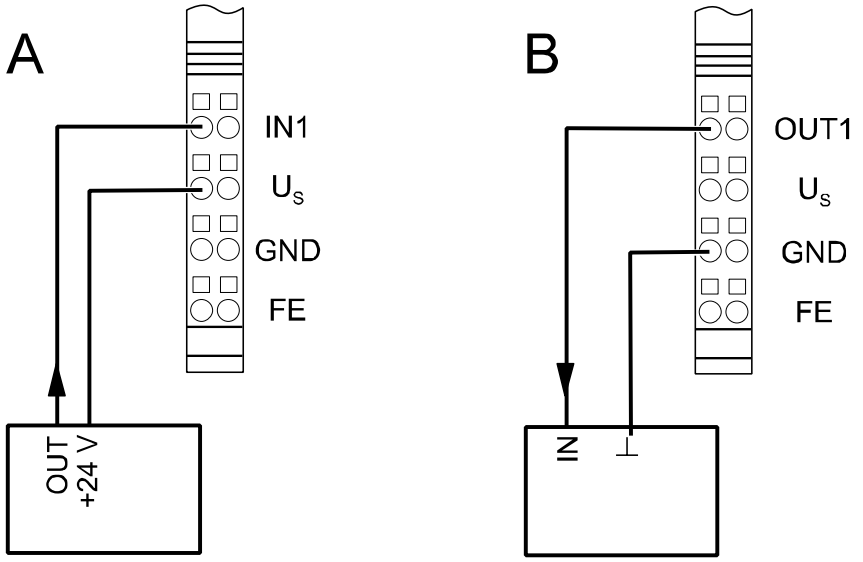


Figure 3.8.4.1: 2-wire connection of digital sensors (A) and actuators (B)

3.8.5 3-Wire Connection of Digital Terminals

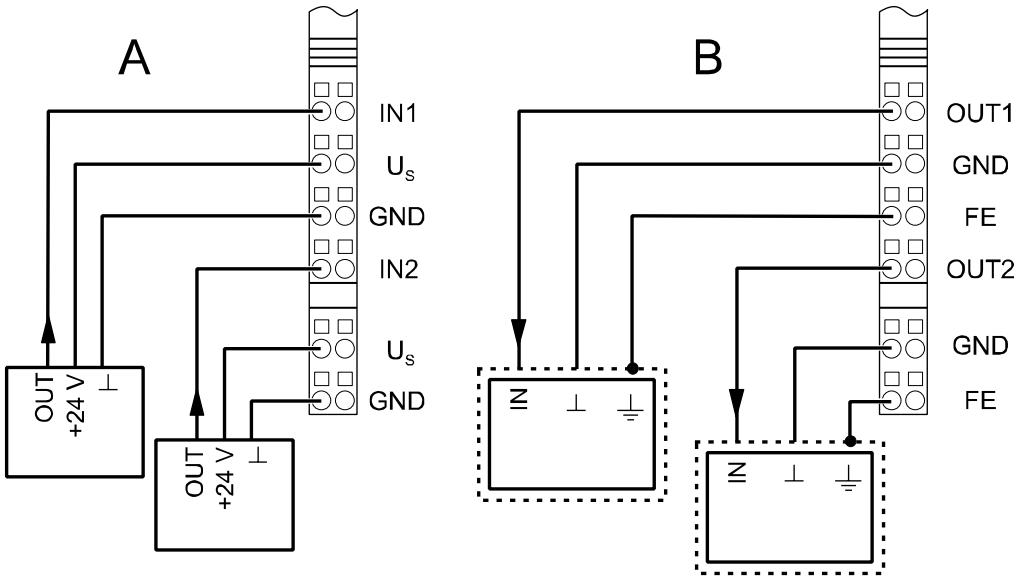


Figure 3.8.5.1: 3-wire connection of digital sensors (A) and actuators (B)

3.8.6 4-Wire Connection of Digital Terminals

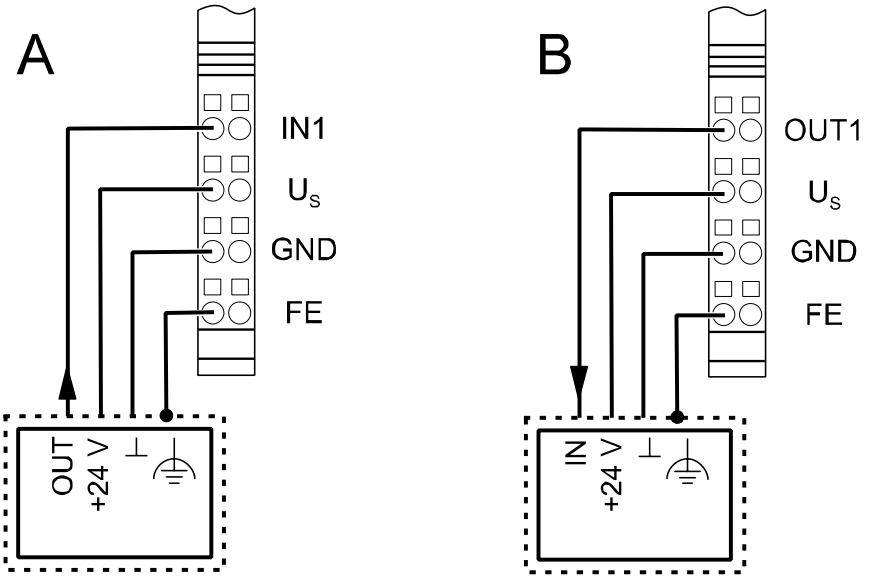


Figure 3.8.6.1: 4-wire connection of digital sensors (A) and actuators (B)

3.8.7 Connecting Analog Terminals

All analog output terminals provide 2-wire connection with the signals output and ground. Some analog output terminals offer additionally a clamping spot for shield connection.

Analog input terminals provide 2-, 3- or 4-wire connection, depending on terminal type. The function of the terminal points depends on the sensor type, differentiated between passive or active and resistance, current or voltage sensors.

The wiring of the analog terminals depends of the terminal type.

Note: When wiring analog terminals please observe the terminal specific data sheets as the wiring of analog terminals differs from that of the digital terminals.

4 Project Creation with Inline

4.1 General

The versatility of Inline provides the user with a high degree of freedom creating the project. There is not only one solution option but several alternatives allowing for different options related to both, price and functionality.

The answer to the question whether an ICS Inline station is basically suited for a project depends on few basic conditions:

- Mounting rail assembly in a switch cabinet
- Space requirements
- Degree of protection IP 20
- 24 V DC supply

The creation of a project starts with the analysis of the task to determine data points, communication relations and the system concept.

A next step is the installation of the Inline components whereby some basic conditions have to be observed such as the order of the in- and output terminals within the station.

Testing the installation is an important step to commissioning the system.

Maintenance includes trouble shooting, modification and extension of an Inline station.

4.2 Definition of the Project

4.2.1 Data Points

Determination of the data points is part of the task analysis. The result is a tabular overview of all data points existing within the project (see table 4.2.1.1).

Property	Description	Meaning
General		
Direction	Sensor or actuator / input or output	
Signal type	Analog, digital or bus protocol (e.g. DALI)	
Voltage area	24 V DC, 120 V AC or 230 V AC	Building of separate voltage areas
Digital Actuators		
Switching characteristics	Operating cycles, switching frequency	Relay or semiconductor switch
Current	Max. current, rated current, inrush current	Choice of relay contact material; current carrying capacity
Analog Actuators		
Voltage	Voltage range	
Current	Current range or max. load	
Digital Sensors		
Type	Voltage or dry contact	Using an auxiliary voltage
Frequency	Switch input, counter pulses of 16 Hz (S0) or more	Choice of digital or pulse counter inputs
Analog Sensors		
Type	Voltage, current or resistance	
Input range		
Speed	Sample rate	Interpretation of results, type of control
Special Functions and Bus Protocols (e.g. DALI, S0 pulse counter)		
See setup and properties of the respective system.		

Table 4.2.1.1: Data point properties

4.2.2 System Structure

Further to the individual properties of the data points, the distribution and the communication relations among each other have to be determined. The assignment of the data points to the individual Inline stations is the result of this analysis. The following basic conditions should be observed:

- Time-critical procedures (e.g. button switches light) should be realized, if possible, in one station.
- The length of actuator/sensor cables generally should be less than 30 m. Please observe the indications in the module specific data sheet.
- In many cases the switch cabinet limits the width of the Inline station.

4.3 Configuration of the Station

The selection of the Inline terminals can be realized by means of the data point list made up in section 4.2.1., whereby the following basic rules apply:

- Homogenous signals should be reduced to as little multi-channel terminals as possible.
- The terminals are supplied by the different circuits (U_L, U_M / U_S, U_{ANA}) of an Inline station. The power requirement can be found in the specific data sheets. Please observe that the maximum admissive currents are not exceeded. If necessary, add supply terminals. The IO Configurator of the IPOCS development environment supports the power requirement calculation of the station and calculates the total length of the station to verify the space requirements in the switch cabinet.

Within a station the terminals should be arranged in the order stated in section 3.6. If a station includes both voltage ranges, 24 V DC and 230 V AC, the 24 V DC range should begin directly at the bus controller and the 230 V AC range should be arranged, if possible, at the end of the station. If another 24 V DC range is located behind a 230 V AC range, a supply terminal has to be set for the latter.

4.4 Installation

Check the installation using the following checklist:

- Are all terminals located in their designated position? You can check the proper arrangement on the basis of the color identification of the function (see section 2.5.3)
- Are the terminals properly latched (see section **Fehler! Verweisquelle konnte nicht gefunden werden.**)? Gaps between the terminals signify faulty latching.
- Is the additional functional earth connection of the bus controller available and properly realized (see section 3.3.1)?
- Are 120 V AC / 230 V AC areas separated by distance terminals (see sections 3.5.5 and 0)? These areas are characterized by their gray housing color, the distance terminals by their gray/green plug.
- Has the end plate been mounted?
- Has the station been mechanically secured on both sides by end clamps?

4.5 Commissioning

A number of tests to check the installation can even be conducted prior to programming and configuration of the bus controller. Please proceed as follows:

1. Establish the supply voltage. The bus controller now boots. This may take a few tens of seconds and is indicated by the service LED of the bus controller illuminated yellow (see [1]). You recognize that the boot procedure is completed once the service LED goes out and the RUN LED is illuminated red or green.
2. Check the LEDs of the bus controller (see [1]) and the Inline terminals (see section 2.6). Especially turn your attention to the diagnosis LED (D). If the local bus runs properly, it has to be continuously illuminated on all terminals.

4.6 Wiring Test

During the wiring test cabling of the connected sensors and actuators is verified as well as the bus wiring (TP/FT-10, Ethernet) of the bus controller.

Depending on the type, in- and output terminals are provided with status indicators to display the signal level. This applies in particular to terminals with digital in- and outputs.

The wiring of the digital sensor connections can be checked by manipulation of the sensor signals.

The display and keypad feature of the ICS bus controllers bearing the code ‚M' allows for manual setting of the digital and analog outputs, independent from the application, provided that the application does not deactivate this function.

The Ethernet wiring can be checked by the behavior of the Link and the Speed LED (see [1]).

The wiring of the TP/FT-10 connection can be checked by a communication test (sending a service message via service button and receiving it using an appropriate Tool).

4.7 Software Project Planning

Software project planning and development are achieved with IPOCS. Please get the appropriate information from [4] and the documentation included in the installation.

IPOCS is beyond pure Software development. For example the IPOCS IO Configurator supports you in terminal selection and configuration of the station. Further tools such as the PlugInCreator for the generation of LNS-Plugins and web visualization are part of the IPOCS tool suite.

4.8 Maintenance

4.8.1 Trouble Shooting

For trouble shooting proceed as for installation (see 0) and commissioning (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).

For error diagnostics please use the diagnosis and status LEDs on the Inline terminals (see 2.6), the specific terminal documentation and in particular the ICS manual [1]. This manual includes a section with typical error descriptions and their possible cause.

When exchanging terminals please observe the directions in section **Fehler! Verweisquelle konnte nicht gefunden werden.**.

4.8.2 Modification and Extension

For modification and extension of the Inline station please make sure that the respective terminals are inserted, according to their type, at the proper position within the Inline station (see section 3.6) and their voltage range (see section 3.5.5).

Usually terminal configuration and software have to be adapted if terminals are added.

5 Technical Data

For the technical data of the Inline system and the terminals please refer to [3] and the documentations of the respective terminals.

Following please find selected technical data related to the Inline system.

System data	
Number of devices in an Inline station	max. 63 devices (automation terminals)

Bus Controller Supply U_{BK}	
Nominal voltage	24 V DC
Ripple	± 5 %
Permissible voltage range	19.2 V DC to 30.0 V DC, ripple included
Logic Circuit UL	
Nominal voltage	7.5 V DC
Ripple	± 5 %
Load current	max. 2 A (observe derating, see [1])

Analog circuit U_{ANA}	
Nominal voltage	24 V DC
Ripple	± 5 %
Permissible voltage range	19.2 V DC to 30.0 V DC, ripple included
Load current	max. 0.5 A

Main and Segment Circuit UM and US	
Nominal voltage	24 V DC
Ripple	± 5 %
Permissible voltage range	19.2 V DC to 30.0 V DC, ripple included
Load current	max. 8 A

Connectors	
Connection type	spring-clamp
Rated cross section	0.2 mm² to 1.5 mm², AWG 24-16
Insulation stripping length	8 mm

Environmental Conditions	
Note: This information represent standard values for the Inline system. For detailed information please refer to the manual of the particular device.	
Operating temperature	-25 °C to 55 °C
Storage temperature	-25 °C to 85 °C
Degree of protection (IEC 60529)	IP20

Table 0.1: Technical data

6 Order Information

6.1 ICS and Accessories

Variant	Configuration	Part no.
ICS-709	TP/FT-10	1226-100202-01-7
ICS-709M	TP/FT-10, display and keypad	1226-100202-02-4
ICS-709-I	TP/FT-10, IP	1226-100202-18-5
ICS-709M-I	TP/FT-10, IP, display and keypad	1226-100202-19-2
ICS-852	TP/FT-10, IP, IP-852, LPA	1226-100202-03-1
ICS-852M	TP/FT-10, IP, IP-852, LPA, display and keypad	1226-100202-04-8
ICS-852X	TP/FT-10, IP, IP-852, LPA, router	1226-100202-09-3
ICS-852MX	TP/FT-10, IP, IP-852, router, LPA, display and keypad	1226-100202-05-5
ICS-709-B	TP/FT-10, IP, BACnet	1226-100202-07-9
ICS-709M-B	TP/FT-10, IP, BACnet, display and keypad	1226-100202-08-6
ICS-852-B	TP/FT-10, IP, IP-852, LPA, BACnet	1226-100202-14-7
ICS-852M-B	TP/FT-10, IP, IP-852, LPA, BACnet, display and keypad	1226-100202-15-4
ICS-852X-B	TP/FT-10, IP, IP-852, router, LPA, BACnet	1226-100202-16-1
ICS-852MX-B	TP/FT-10, IP, IP-852, router, LPA, BACnet, display and keypad	1226-100202-17-8
ICS-709-F	TP/FT-10, IP, Fidelio	1226-100202-06-2
ICS-709-B-F	TP/FT-10, IP, BACnet, Fidelio	1226-100202-33-8
ICS-852-F	TP/FT-10, IP, IP-852, LPA, Fidelio	1226-100202-32-1
Accessories		
ACC-ICS-RJ12-SUB-9F	RS232-cable RJ12 to DSUB-9 female	1151-100231-01-2
ACC-ICS-RJ12-RS485	RS-485 adapter with cable 150 mm	1151-100366-01-1
IPOCS-USB	IPOCS-4.1 full version; USB dongle	1503-100081-13-3
IPOCS-C	IPOCS-4.1 full version; parallel port dongle	upon request

Table 6.1.1: Order information for ICS and accessories

6.2 Supported Inline Automation Terminals

Device 1)	Function	Part no.1)
Digital Input/Output Terminals		
IB IL 230 DI 1-PAC	1 input 230 V	2861548
IB IL 24 DI 2-PAC	2 inputs 24 V	2861221
IB IL 24 DI 4-PAC	4 inputs 24 V	2861234
IB IL 24 DI 4-ME	4 inputs 24 V	2863928
IB IL 24 DI 8/HD-PAC	8 inputs 24 V, 1 DU	2700173
IB IL 24 DI 8-PAC	8 inputs 24 V	2861247
IB IL 24 DI 16-PAC	16 inputs 24 V	2861250
IB IL 24 DI 16-ME	16 inputs 24 V	2897156
IB IL 24 DI 32/HD-PAC	32 inputs 24 V	2862835
IB IL 24 DO 2-PAC	2 transistor outputs 24 V DC / 0.5 A	2861470
IB IL 24 DO 2 2A-PAC	2 transistor outputs 24 V DC / 2 A	2861263
IB IL 24 DO 4-PAC	4 transistor outputs 24 V DC / 0.5 A	2861276
IB IL 24 DO 4-ME	4 transistor outputs 24 V DC/ 0.5 A	2863944
IB IL 24 DO 8/HD-PAC	8 transistor outputs 24 V DC/ 0.5 A, 1 DU	2700172
IB IL 24 DO 8-PAC	8 transistor outputs 24 V DC/ 0.5 A	2861289
IB IL 24 DO 8 2A-PAC	8 transistor outputs 24 V DC/ 2 A	2861603
IB IL 24 DO 16-PAC	16 transistor outputs 24 V DC/ 0.5 A	2861292
IB IL 24 DO 16-ME	16 transistor outputs 24 V DC/ 0.5 A	2897253
IB IL 24 DO 32/HD-PAC	32 transistor outputs 24 V DC/ 0.5 A	2862822
Relay Terminals		
IB IL 24/230 DOR 1/W-PAC	1 change over contact 230 V / 3 A	2861881
IB IL 24/230 DOR 1/W-PC-PAC	1 change over contact 230 V / 3 A	2862178
IB IL 24/48 DOR 2/W-PAC	2 change over contacts 48 V / 2 A	2863119
IB IL 24/230 DOR 4/W-PAC	4 change over contacts 230 V / 3 A	2861878
IB IL 24/230 DOR 4/W-PC-PAC	4 change over contacts 230 V / 3 A	2862181
IB IL 24/230 DOR 4/HC-PAC	4 bistable 230 V / 16 A, high inrush current	2897716
TRIAC Terminals		
IB IL DO 1 AC-PAC	1 x TRIAC 12-253 V AC / 0.5 A	2861920
IB IL DO 4 AC-1A-PAC	4 x TRIAC 12-253 V AC / 1 A	2861658
Analog Input Terminals		
IB IL AI 2/SF-PAC	2 x voltage, current	2861302
IB IL AI 2/SF-ME	2 x voltage, current	2863944
IB IL TEMP 2 RTD-PAC	2 x resistance, temperature	2861328
IB IL AI/TEMP 4 RTD-PAC	4 x voltage, resistance, temperature	2897952
IB IL AI 4/EF-PAC	4 x voltage, current	2878447
IB IL TEMP 4/8 RTD-PAC	8 x resistance, temperature	2863915
IB IL AI 8/SF-PAC	8 x voltage, current	2861412

Analog Output Terminals		
IB IL AO 1/SF-PAC	1 x voltage, current	2861315
IB IL AO 1/U/SF-PAC	1 x voltage	2861399
IB IL AO 2/SF-PAC	2 x voltage, current	2863083
IB IL AO 2/U/SF-PAC	2 x voltage	2861467
IB IL AO 2/U/BP-ME	2 x voltage	2863957
IB IL AO 4/U/SF-PAC	4 x voltage	2692050
IB IL AO 4/8/U/BP-PAC	8 x voltage	2878036
Function and Communication Terminals		
IB IL DALI/PWR-PAC	DALI master with DALI supply	2897813
IB IL DALI-PAC	DALI master, extension terminal	2897910
IB IL DALI/MM-PAC	DALI master with DALI supply, multi master support	2700605
IB IL DI/S0-PAC	8 S0 counter inputs / digital inputs	2897020

[1)] Device names and part numbers of Phoenix Contact apply.

Table 6.2.1: Automation terminals supported by ICS

Note: All terminals listed in table 6.2.1 are approved for the use in the ICS. If other terminals are to be used please contact SysMik [7]!

6.3 Power and Segment Terminals

Device[1)]	Function	Part no.[1)]
IB IL 24 PWR IN-PAC	24 V feed in	2861331
IB IL 24 PWR IN/F-PAC	24 V fused feed in	2861438
IB IL 24 PWR IN/2-F-PAC	24 V fused feed in	2862136
IB IL 24 PWR IN/2-F-D-PAC	24 V fused feed in with diagnostics	2862152
IB IL 24 PWR IN/2F-DF-PAC	24 V fused feed in with diagnostics	2863779
IB IL 24 PWR IN/R-PAC	Supply of bus electronics (U_L, U_{ANA})	2861674
IB IL 24 SEG-PAC	24 V segment supply	2861344
IB IL 24 SEG/F-PAC	24 V fused segment supply	2861373
IB IL 24 SEG/F-D-PAC	24 V fused segment supply with diagnostics	2861904
IB IL 24 SEG-ELF-PAC	24 V fused segment supply	2861409
IB IL PD 24V-PAC	Distribution of 24 V segment voltage	2862987
IB IL PD GND-PAC	Distribution of GND	2862990
IB IL 230 PWR IN-PAC	230 V feed in	2861535
IB IL DOR LV-SET-PAC	Spacer terminal to separate 230 V and 24 V	2861645

[1)]) Device names and part numbers of Phoenix Contact apply.

Table 6.3.1: Power and segment terminals

6.4 Inline Accessories

Designation[1)]	Description	Part no.[1)]
IL CP	Coding profile, 100 pcs/package	2742683
ZB 6	Zack strip (see Phoenix catalog „CLIPLINE“)	
IB IL FIELD 2	Labeling field for one plug (12.2 mm)	2727501
IB IL FIELD 8	Labeling field for four plugs (48.8 mm)	2727515
ESL 62X10	Insert strip for IB IL FIELD 2, perforated, for laser printers, 72-parts, 1 piece/package	0809502
ESL 62X46	Insert strip for IB IL FIELD 8, perforated, for laser printers, 15-parts, 5 pcs/package	0809502
CLIPFIX 35	End bracket, snap-on without tools	3022218

[1)]) Device names and part numbers of Phoenix Contact apply.

Table 6.4.1: Order information for Inline accessories

7 Glossary

Term	Explanation
BACnet	ISO EN16484.5 communication protocol for building automation with generic objects to be implemented manufacturer specific.
CEA-709	International standard based on extended LONWORKS specifications for the communication protocol including physical transmission procedures on different media compliant with the LONMARK definition. In Europe standardized equivalent as EN-14908 Control Network Protocol („CNP“).
CEA-709.1	Standard of the communcation protocol known als LON "Control Network Protocol Specification"
CEA-852	Use of the IP channel as transmission medium for the LONWORKS protocol
Echelon	Company that invented and marketed control networks
FE	Functional Earth
GND	Ground, 0 V
ICS	InlineControlServer for LONMARK and BACnet applications (SysMik). Bus controller for the scalable I/O terminal system Inline Modular (Phoenix Contact), optional with WEB server.
IPOCS	Graphic programming tool for controllers and I/O modules (by SysMik)
IP-852	Channel type specified by LONMARK based on CEA-852 for tunneling of the 709 protocol via IP internet protocol
Local bus	Channel for the communication of the Inline bus controller with the automation terminals within an Inline station
LONMARK Germany	German user organization – membership corporation; affiliate of LONMARK International
LONMARK International	Global manufacturer and user association standardizing profiles for specific applications and Interoperability Guidelines
LONWORKS	Trade name for the technology platform for control networks by Echelon primarily including the ANSI-/CEA-709.1 standardized communication protocol, the Neuron microprocessor, transceiver modules for TP/FT-10 and Powerline and LNS
LPA-Back-End	Software module on the ICS enabling the evaluation of the CEA-709 network traffic with an protocol analyzer by Loytec
Neuron	LONWORKS chip, LONWORKS communication controller etc. provided by Echelon; central part of the most existing CEA-709 nodes

RNI	„Remote Network Interface“. External network interface directly at the CEA-709 network; communication with the control station via IP using a specific protocol.
TP/FT-10	Channel type specified by LONMARK; standard Twisted Pair technology with free topology, most common channel type, 78 kBit/s
U_{ANA}	Supply of the analog circuit
U_{BK}	Supply of the bus controller
U_L	Supply of the logic circuit
U_M	Supply of the main circuit
U_S	Supply of the segment circuit

8 Literature

[1] ICS Manual, SysMik GmbH Dresden, 2007

[2] www.phoenixcontact.com

[3] User manual IL SYS INST UM E: "Automation Terminals of the Inline Product Range", Phoenix Contact, Phoenix order no. 2698737

[4] IPOCS, First Steps in IPOCS 4.1, SysMik GmbH Dresden (part of IPOCS 4.1.x installation)

[5] LONWORKS FTT-10A Free Topology Transceiver User's Guide, Echelon Corporation

[6] LONWORKS Wiring Guidelines, SysMik GmbH Dresden

[7] www.sysmik.com